Research Report 2012

Developing Exemplar Interactive Multimedia Instruction for Unmanned Aircraft System Repairers

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14. ABSTRACT

This research aimed to develop and apply systematic principles for the development of effective Interactive Multimedia Instruction (IMI) that can be broadly applied to Army courses and to build and evaluate exemplar IMI for an Army Advanced Individual Training (AIT) course. This research developed exemplar IMI for Unmanned Aircraft System (UAS) Repairer course material that is consistent with those principles. This research compared the effectiveness of IMI against the current live instruction for UAS Repairer course material and also compared the effectiveness of two different IMI design approaches used to progress the learner through the various training modules—one IMI that is controlled by the learners (freedom to choose the order of modules) and the other IMI that is controlled by the designers (in a lock-step manner). Results indicate that using IMI for initial training is an effective alternative to live training for the MOS 15E UAS Repairer AIT.

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Interactive Multimedia Instruction (IMI), instructional design principles, Unmanned Aircraft Systems (UAS), UAS Repairers, learner-controlled IMI, designer-controlled IMI

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DEVELOPING EXEMPLAR INTERACTIVE MULTIMEDIA INSTRUCTION FOR UNMANNED AIRCRAFT SYSTEM REPAIRERS

EXECUTIVE SUMMARY

Research Requirement:

The Charlie Company, 2-13th Aviation Regiment, 1st Aviation Brigade, and Department of the Army Civilian Training Instructor Unmanned Aviation Systems (UAS) Enabling Skills Branch, Fort Huachuca, AZ, requested research to address how the Army Learning Model's concept of providing innovative training methods that build and deliver highly adaptable, versatile, easy-to-access, and learner–centric skills training could be applied to their current program of instruction (POI). The Enabling Skills Branch does not have access to Interactive Multimedia Instruction designers, graphic artists, or programmers. Therefore, they requested that this research provide guidance to the instructors on how to design effective Interactive Multimedia Instruction.

Procedure:

Based on POI input from the 2-13th instructor cadre, we identified relevant course topics for exemplification. These modules included the relatively static material (i.e., material that does not change much over time) found in their Common Aircraft Hardware and Securing Devices, Hydraulics Theory and Components, and Precision Tools modules. Pre- and post-instructional assessments were administered. For the Common Aircraft Hardware and Securing Devices module, we compared the Interactive Multimedia Instruction version to live instruction. For the Hydraulics Theory and Components, we compared the learner-controlled Interactive Multimedia Instruction and the designer-controlled Interactive Multimedia Instruction to live instruction. Lastly, the course instructors developed Interactive Multimedia Instruction for the Precision Tools module that was compared to live instruction.

Findings:

Results indicate that all students showed an increase in knowledge from pre- to post-assessment, independent of the modality of instruction (live versus Interactive Multimedia Instruction). Further, there were no differences between the post-assessment scores based on the modality of instruction. In this report, we discuss the implications for these results as they pertain to the instructor.

Utilization and Dissemination of Findings:

This report aimed to determine the value of using Interactive Multimedia Instruction versus live instruction. The results of this research were presented to the instructor cadre and leadership of Charlie Company, 2-13th Aviation Regiment, 1st Aviation Brigade, and Department of the Army Civilian Training Instructor (UAS) Enabling Skills Branch, Fort Huachuca, AZ.

DEVELOPING EXEMPLAR INTERACTIVE MULTIMEDIA INSTRUCTION FOR UNMANNED AIRCRAFT SYSTEM REPAIRERS

CONTENTS

Developing Exemplar Interactive Multimedia Instruction for Unmanned Aircraft System Repairers

Introduction

U.S. Army course proponents and training developers often face tight training schedules that limit the number and depth of topics that can be reasonably covered in a given training program. Excluding one topic in favor of including or expanding on another may lead to deficiencies in essential knowledge and skills following graduation from initial military training. Many Army courses use computer-based training (CBT), specifically Interactive Multimedia Instruction (IMI) to enhance the efficacy of training within the time and resources allocated to them. Blankenbeckler, Graves, and Wampler (2014) suggest that most IMI efforts appear to be piecemeal and do not seem to follow an evidence-based development strategy. This research addresses this limitation and implements the evidence-based development strategy of the Army Learning Model (Department of the Army, 2011) by providing innovative training methods that build and deliver highly adaptable, versatile, easy-to-access, and learner-centric training of skills and expands upon TRADOC's Army Educational Processes Pamphlet 350-70-7 (Department of the Army, 2013).

In this research, we examined the impact of IMI in an exemplar training environment and determined how better to develop in-house IMI training efforts in the future. This research focused on the Unmanned Aircraft System (UAS) Repairer (MOS: 15E) advanced individual training course conducted at the 2-13th Aviation Regiment (2-13AV), 1st Aviation Brigade (UAS Training Battalion, Fort Huachuca, AZ). Recent revisions to the UAS Repairer course have brought with them a need to develop in-house IMI for UAS Repairer modules and topics. In an effort to augment direct live instruction, the 2-13th course instructors/in-house developers have been using self-built IMI modules to present course material and test students. Some of their current in-house-developed IMI for UAS Repairers is used as refresher training or as in-class reinforcement of course material. Moreover, according to the 2-13th AV leadership, the currently used IMI was developed by individual course instructors with very little IMI development experience, little experience with graphic design and rudimentary software programming skills, and no clear guidance on how to effectively develop or integrate learning-based principles and techniques within the IMI. A companion paper describes the processes employed to develop a CBT Principles Guide and a User's Guide based upon the principles of learning theory, which was delivered to the UAS Training Battalion for their subsequent IMI development efforts (Ingurgio, Blankenbeckler & Wampler, in press).

The instructional topics for this research were determined from a needs analysis of UAS Repairer course material. This research: (a) developed exemplar IMI for UAS Repairer course material that is consistent with the CBT principles of the companion report; (b) compared the effectiveness of IMI against the current live instruction for UAS Repairer course material; (c) compared the effectiveness of two IMI design approaches (learner- versus designer-controlled), where learner-controlled design is built to allow the learner the freedom to choose their progress through the training modules and the designer-controlled design is built so the learner progresses

in a lock-step manner through the training modules; and (d) evaluated an in-house IMI effort designed and developed by the instructors.

Method

Participants

Seventy-three (*N* = 73) Soldiers enrolled in the Unmanned Aerial Systems (UAS) maintainers Advanced Individual Training (AIT) course at Fort Huachuca, AZ participated in this research. Soldiers were assigned to classes based on their AIT enrollment. The experiment was designed to evaluate the same content between the three course topics' live instruction (*n* = 31 Soldiers) and the exemplar IMI modules (*n* = 42 Soldiers). The Hydraulic Theory and Components module evaluated the two differently designed IMI modules to assess any differences between the learner-controlled IMI and the designer-controlled IMI, against live instruction.

Course Materials

Because the Common Aircraft Hardware and Securing Devices, Hydraulics Theory and Components, and Precision Tools modules were already being taught in the live environment, the existing instructional content and appropriate reference materials were used as the basis for determining the content of the exemplar IMI modules. The intent was to cover the same content, but use IMI as the presentation format, with the IMI modules employing the design principles contained in the CBT Principles Guide to increase learning effectiveness.

In addition, the IMI modules used enhanced graphic images from what was used for the live instruction and included the multimedia capabilities of IMI (e.g., animation, interaction, and narration), in an effort to provide the same information that an instructor would present to students in the live instructional environment. The target users for the exemplar IMI in this research were Soldiers who are generally unfamiliar with the course topics, so the content was presented at a basic level. All IMI modules were built with Adobe's Captivate® authoring tool software.

Experimental Design

Three UAS Repairer IMI modules were developed, and the effectiveness of each was compared to the current live instruction covering the same material. The three UAS Repairer modules selected were Common Aircraft Hardware and Securing Devices, Hydraulics Theory and Components, and Precision Tools. These modules were selected because they contain static material—not much, if any, of the material is expected to change over time. Both the Common Aircraft Hardware and Securing Devices and the Precision Tools modules were compared to live instruction.

However, for the Hydraulics Theory and Components module only (the other modules were compared against the designer-controlled IMI), two versions of the same IMI content were

developed and compared to live training: One version was the designer-controlled IMI, where the participant followed a structured path through the material and the second version allowed the participants to determine their own path through the material (learner-controlled IMI). Further, the Common Aircraft Hardware and Securing Devices and the Hydraulics Theory and Components modules were designed and developed by IMI experts; whereas the Precision Tools module was designed and developed by the 2-13th instructors and reviewed by the experts for adherence to the CBT Principles Guide.

Testing occurred over seven sessions, lasting approximately 2 to 3 hours per session. Soldiers did not participate in more than one session. Table 1 provides information on the testing sessions. At the start of a session, the Soldiers were briefed on the purpose of the research and then they read the informed consent form (Appendix A). They were then asked to complete a demographic questionnaire that included a self-rating of their existing knowledge and experience with the class material to be presented for that session (see Appendix B for an example) and to complete the IMI Rating Questionnaire, a measure of their understanding of IMI.

Table 1

Testing Session Information

	Live instruction		Exemplar IMI Module		
Class topic	Content time	# of Soldiers	Content time	# of Soldiers	Other time*
Hardware	2 hours	10	2 hours	11	1 hour
Tools	1 hour	11	1 hour	9	1 hour
Hydraulics (Designer)	1 hour	10	1 hour	6	1 hour
Hydraulics (Learner)	included with the Hydraulics (Designer) above		1 hour	16	1 hour

Notes: Hardware = Common Aircraft Hardware and Securing Devices
Tools = Precision Tools
Hydraulics = Hydraulic Theory and Components
*Other time includes administrative instructions and the completion of pre- and post-tests.

Following the administrative instructions at the start of each session, Soldiers were administered a pre-test for the class topic. Each class topic had two alternate test forms that were matched, question-by-question, for content. For randomization purposes, if a Soldier received Form A before training (pre-test), they then received Form B after training (post-test), and vice versa (see Appendix C for an example of these alternative forms). Presentation of the testing forms was counterbalanced between the two instructional modalities. Once the pre-test was completed, it was then collected by a researcher and securely filed. For the live instruction sessions, the instructor then presented the class topic using his or her existing training materials. For the exemplar IMI module sessions, Soldiers were allowed to complete the IMI training at their own pace. At the end of either training session, Soldiers completed a post-test. Soldiers

who participated in one of the exemplar IMI module sessions were also asked to complete a questionnaire rating various aspects of the IMI module (see Appendix D).

Results

All data were analyzed with the appropriate descriptive statistics. Written comments were analyzed for themes and trends. As a reminder, a total of 73 Soldiers participated in this research, over seven different data collection sessions. The first row of Table 2 shows the distribution of Soldiers by the seven data collection sessions, ranging from six to 16. Sixty of the Soldiers were receiving training for their first Military Occupational Specialty (MOS) assignment. The 13 more experienced Soldiers new to this MOS averaged approximately 5 years of duty, with a total of 13 deployments among them. Their distribution across the seven data collection sessions were: two in the Hardware Live session, four in the Hardware IMI session, five in the Hydraulics Live session, and two in the Hydraulic-Designer controlled IMI session.

Table 2

Pre- and Post-Test Average Percent Correct by Topic and Instructional Modality

	Hardware mean (SD)		Precision Tools mean (SD)		Hydraulics mean (SD)		
Measures (N = 73)	Live (n = 10)	IMI (n = 11)	Live (n = 11)	IMI (n = 9)	Live (n = 10)	IMI (Designer) (n = 6)	IMI (Learner) (n = 16)
Pre-test score	56 (9.1)	58 (12.1)	63 (10.0)	73 (11.7)	58 (17.7)	64 (13.8)	58 (18.3)
Post-test score	74 (8.1)	76 (9.9)	77 (6.5)	79 (10.2)	81 (6.9)	89 (5.9)	82 (7.9)
Improvement from pre- to post-test	18 (9.2)	18 (8.4)	14 (7.2)	6 (12.3)	23 (18.1)	25 (17.3)	24 (19.6)

Live Instruction Versus Exemplar Interactive Multimedia Instruction Modules

To determine the parallel-forms reliability for each of the pre- and post-test versions for the three modules, a correlation analysis was performed on the total scores and all *r*'s ranged between .32 and .62. Additionally, the subject matter experts who developed these parallel forms manipulated the order of items and the order of responses, as well as making minor changes to the illustrations (sometimes inverting images, changing bolt types, changing colors,

etc). Further, for each module, the two versions were previewed by the trainers and were deemed acceptably parallel.

Each of the pre- and post-test forms (see Appendix C examples) were scored in a manner that represented all the possible answers for each question. The majority of test questions were designed so that multiple responses could be correct. For those questions with multiple correct responses, the Soldier did not know how many responses were correct—just that it was possible that more than one answer could be correct, and the instructions stated that the Soldier should select all responses that apply. Further, each question indicated whether it had a single or multiple correct answer(s), and all questions had "I don't know" as a response option. With the exception of matching questions (see C-6/C-16 for an example), the maximum score on any question was four points. If the "I don't know" response was chosen, no points were awarded for that question. To provide Soldiers with credit for making the correct response(s) (and credit for not making an incorrect response for those items with multiple correct answers), a scoring method was employed that accounted for all the response options. For all questions, if the Soldier selected the answer(s) that was/were correct, a single credit point was awarded for each. Further, if the Soldier correctly did not select the answer(s) that should not have been selected, a single credit point was awarded for each. If the Soldier did not select any responses, no points were recorded for that question. In this manner, a Soldier received credit for selecting the correct responses and also received credit for not selecting the incorrect responses. For example, a question with five possible response options—that had three correct responses, one incorrect response, and the "I don't know" response—could result in a maximum score of four for that question. If a Soldier identified only two of the correct responses (two points; and omitted selecting the other correct response—no point) and did not select the incorrect response (one point), his or her score for that item would be three points. Table 2 also represents the average percent of correct responses for each of the seven instructional sessions and the percent of improvement from pre- to post-test.

With regard to the instructional modality (live versus IMI), there were no pre- or post-test significant differences between the three topics: Common Aircraft Hardware and Securing Devices (pre: $t(20) = 0.58$, $p > .05$ and post: $t(20) = 0.64$, $p > .05$), Hydraulic Theory and Components (pre: $t(31) = 0.75$, $p > .05$ and post: $t(31) = 0.37$, $p > .05$; to compare the two instructional modalities, we collapsed the scores for the learner- and designer-controlled groups to represent IMI—these are broken out in the next section), and Precision Tools (pre: $t(19) = 0.05$, $p > .05$ and post: $t(19) = 0.06$, $p > .05$). The post-test score for Designer-Controlled IMI for Hydraulic Theory and Components is slightly higher than the others, but this may be due to the very small sample size for that group. Our observations indicated that few students, if any, seemed to take full advantage of the features of the learner-controlled IMI. However, the IMI for Precision Tools pre- to post-test improvement is somewhat reduced (6%) compared to all the other groups; this may be due to the fact that the Precision Tools IMI pre-test score was fairly high at 73%, and therefore, there was less room for improvement.

Learner- Versus Designer-Controlled Interactive Multimedia Instruction

We did not anticipate any differences between the learner- and designer-controlled IMI with regard to performance. Both of these control designs contained identical information in the modules; the only possible difference was the order of presentation. The learner-controlled

module allowed the learner to select his or her path through the material, and it is conceivable, although we have no evidence to confirm it, that the learner could have proceeded in an orderly fashion replicating the designer-controlled module. With regard to the pre- and post-test scores for the Hydraulic Theory and Components module, there were no statistical differences observed between the learner- and designer-controlled conditions (pre: $t(21) = 0.45$, $p > .05$ and post: $t(21) = 0.05$, $p > .05$). Further, there were no statistical differences observed between the learner-controlled and live conditions (pre: $t(25) = 0.93$, $p > .05$ and post: $t(25) = 0.83$, $p > .05$), nor for the designer-controlled and live conditions (pre: $t(15) = 0.44$, $p > .05$ and post: $t(15) = 0.04$, $p > .05$).

Prior Knowledge and Experience

We assumed that Soldiers had different background knowledge and experience with the respective topic domains, and so we evaluated their prior knowledge and experiences for those topics. All Soldiers indicated their prior knowledge and experience with regard to which of the three different classes they attended (Common Aircraft Hardware and Securing Devices, Hydraulics Theory and Components, or Precision Tools). The full range of prior knowledge and experience responses were from one to nine. One through three indicated "None or Little" knowledge; 3.1 through six indicated "Moderate" knowledge; and, 6.1 through nine indicated "Extensive" knowledge. As shown in Table 3, all Soldiers had, on average, a "Moderate" amount of prior knowledge and experiences of the class topics, with the exception of Hydraulics Theory and Components, where the designer-controlled IMI class had "None or Little" average prior knowledge. With regard to prior knowledge and experiences, the difference between the designer-controlled IMI and the live classes was not significant ($t(15) = 0.21$, $p > .05$). Likewise, there was no statistical difference observed between the learner- and designer-controlled conditions with regard to prior knowledge and experience ($t(21) = 0.66$, $p > .05$).

Table 3

Self-Ratings of Prior Knowledge and Experience by Class Topic

	Hardware mean (*SD*)		Precision Tools mean (*SD*)		Hydraulics mean (*SD*)		
	Live ($n = 10$)	IMI ($n = 11$)	Live ($n = 11$)	IMI ($n = 9$)	Live ($n = 10$)	IMI (Designer) ($n = 6$)	IMI (Learner) ($n = 16$)
Prior knowledge and experience self-ratings	3.6 (1.5)	5.6 (2.1)	4.3 (1.5)	5.6 (1.3)	4.2 (3.1)	2.7 (1.6)	3.1 (2.2)
Range	1 to 6	3 to 9	1 to 6	4 to 7	1 to 9	1 to 5	1 to 8
Rating	Moderate	Moderate	Moderate	Moderate	Moderate	None or Little	Moderate

Interactive Multimedia Instruction Ratings

At the conclusion of each IMI session, Soldiers (n = 42) completed the IMI Rating Questionnaire. These data were collected as a way for us to measure whether the Soldiers understood the benefits of using IMI in the classroom, as well as to investigate their perspective on using IMI in the classroom. We did not expect to see any differences between the learner- and designer-controlled IMI conditions with regard to these ratings and therefore did not perform this analysis. This questionnaire asked the Soldiers to respond to questions with regard to the 14 main topics of Complexity (amount of the information), Doctrinal Correctness (adherence to doctrine), Graphics (clear and understandable), Face Validity (currency of the Army material), Viable Examples (the realism of the examples), Logical Flow (the sequence of topics), Focus of Presentation (information on-target), Grouping of Content (structure), Appropriate Testing (use of knowledge checks), Interactivity and Navigation (user interface considerations), Length of Training (progress/breaks), Use of Prior Knowledge (aided in recall of previously learned material), Optional Use (how and when to use the IMI), and Outcome Meets Goal (if the IMI met the objectives and goals of the course). Below we summarize the Soldiers' responses to consolidate their responses in a more concise manner. The items listed below were selected because they showed the highest percentages of agreeableness by the students for each main topic. Some items were reverse-scored. All Soldier IMI ratings for the four IMI classes are broken out in Appendix E.

In general, across all four of the IMI sessions, Soldiers felt that:

- the amount of information was just right;
- the information was accurate, current, and doctrinally correct;
- the graphics were supportive, clear, and legible;
- the information was valid with regard to how the Army does things;
- the examples made sense and aided their learning;
- the information flowed well;
- the topics were clearly presented;
- the information was well structured;
- the knowledge checks aided learning;
- the interface and navigation aided learning;
- the length of training was acceptable;
- their prior knowledge of material helped, but was not necessary to learn the information;
- the IMI would be good as a skill refresher, they would recommend its use to others, and they learned a lot about the topic; and,
- the IMI supported their learning and they would be able to apply the information learned as UAS repairs.

Discussion

As we continue our discussion, be mindful of the fact that, with one exception, we had relatively small sample sizes that may have had an effect on the findings. Also, we performed

more than 10 *t*-tests in our analyses and some may be concerned with the experiment-wise error rate (Type 1 error). We set our probability value at .05 for these tests. However, because we observed no statistical significance in any of our analyses, the effect of performing multiple *t*-tests is not a concern. We developed exemplar IMI for UAS Repairer courses that were consistent with the CBT Principles Guide in Ingurgio et al. (in press); we then compared the effectiveness of those exemplar IMIs against the current live instruction, and we compared the effectiveness of the two different IMI design approaches (learner- versus designer-controlled) against each other and live instruction. However, the results from the pre- and post-tests do not indicate any difference between the modality of instruction (IMI versus live) or between the two differing IMI design approaches.

Prior research has indicated that novice learners tend to prefer training material that guides them through the learning, rather than having to be responsible for learning selection and progression (Blankenbeckler, Graves & Wampler, 2013, 2014; Graves, Blankenbeckler, Wampler, & Roberts, 2016). This leads one to consider that presenting a highly interactive IMI for training new information to someone with no, little, or moderate previous knowledge or experience in a particular topic may not be best. Conceivably, (Graves et al., 2016) for the new learner, the designer-controlled approach, while simple, provides a more traditional approach to learning.

The initial military training environment is somewhat unique. While Soldiers may be assigned or selected for training in a particular MOS because of their Armed Services Vocational Aptitude Battery scores or their display of an acceptable level of general mental ability, few have extensive applicable prior knowledge or skills. Most are being introduced to the basic knowledge and skills related to their MOS for the first time. Even those with rudimentary or related knowledge and skills may find that using or applying this knowledge and skill in a military context or with military equipment is unfamiliar. The trainees needed to "work their way" through the entire module or topic. For the new learner, each frame reveals new information, knowledge, and skills; therefore designer-controlled IMI may be a more cost-effective way for conveying introductory knowledge. It can be safely concluded that IMI of simplistic design can be used to convey basic knowledge and skills. Further, well-designed IMI can be substituted for live presentations with similar measurable outcomes. Again, there were essentially no post-test differences between the three topics—both instructional modalities seemed to convey the desired level of basic knowledge and skills equally well. This predictability would permit the use of IMI while freeing up additional instructor time for small group, applied instruction, or practical exercises. Further, the evidence points to the conclusion that self-reported prior knowledge and experience, as well as the IMI questionnaire ratings, did not have an impact with this sample. It could be that with a more diverse sample, the effects of prior knowledge and experience may impact the results and IMI ratings in ways to be determined.

Based on the findings of this research, we conclude that well-designed IMI may be used to supplement live instruction and provide similar measurable outcomes. Utilizing IMI may allow for additional instructor time to review material, to attend to less gifted students, to conduct small group sessions and discussions, to allow for more applied, hands-on instruction, and to provide time for practical exercises. Finally, future research may focus on how IMI may

be best utilized for training. Is IMI better for initial or advanced training? Is IMI best used as a supplementary aid for training, or is it best used for refresher training? Can IMI be useful for training topics that have materials that vary over time, in contrast to those with "static" material? The answers to these questions will ultimately facilitate the development of IMI designed in-house.

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APPENDIX A

INFORMED CONSENT FORM

UAS Repairer Student Informed Consent

Title: Developing Exemplar Interactive Multimedia Instruction for Unmanned Aircraft System Repairers.

Purpose of the research: The purpose of this research is to develop and apply effective principles for developing computer-based training in the UAS Repairer (15E) Course.

What you will be asked to do in this research: If you agree to participate in this research, you will be asked to complete pre- and post-assessments of your knowledge of information and procedures covered in your UAS Repairer (15E) course.

Voluntary participation: Your participation is voluntary; there is no penalty or loss of benefits to which you are otherwise entitled if you choose not to participate or discontinue participation at any time. You have the right to withdraw from this research at any time without bias. If you decide not to participate, or wish to stop at any time, you will be quietly dismissed and return to duty.

Confidentiality: We will NOT identify you, nor will you be asked to identify yourself on any assessment that you will complete. We will NOT include your name or other personally identifiable information in our notes or report. The data that we are collecting will be analyzed at an aggregate or group level. The report of findings will also be at an aggregate or group level. The results of this assessment will not be shared with your instructors or staff and they will not have any impact on your course results, outcomes, or standings. After the session is over, we ask that each of you respect the confidential nature of this research by not identifying other participants outside of this session. This research is supported by the Department of Defense. Your research records may be reviewed by the Department of Defense to ensure protection of human research subjects.

We cannot provide "confidentiality" or "non-attribution" to a participant regarding comments involving criminal activity/behavior, or statements that pose a threat to yourself or others. Do NOT discuss or comment on classified or operationally sensitive information during this session.

Time required: Total time commitment for this research is approximately 1 to 1.5 hours, depending on the training module we are assessing.

Risks: There are no foreseeable risks greater than those encountered in everyday activities.

Benefits: There are no direct benefits to you. The possible benefit you may gain from participation in this research is a better understanding of the UAS Repairers class materials.

Compensation: There is no personal compensation for participating in this research.

Whom to contact if you have questions about this research: You should send your questions to usarmy.belvoir.hqda-ari.mbx.surveys@mail.mil. Reference project name: Developing Exemplar Interactive Multimedia Instruction for Unmanned Aircraft System Repairers.

Whom to contact about your rights in this research or if you have a research-related injury: Contact usarmy.belvoir.hqda-ari.mbx.surveys@mail.mil. Reference project name: Developing Exemplar Interactive Multimedia Instruction for Unmanned Aircraft System Repairers.

APPENDIX B

EXAMPLE OF DEMOGRAPHIC QUESTIONNAIRE WITH PRIOR KNOWLEDGE AND EXPERIENCE ITEMS

1. Rank _____

2. Service and Component (circle responses):

ARMY – Active USAR NG

USMC – Active Reserve

3. Are you a Soldier or Marine attending this training for award of your initial primary Military Occupational Specialty (MOS)? (circle one)

YES NO

4. If NO, what is your current MOS? _____; time in service?

Years:_____ Months: _____

5. Have you been deployed? YES NO

If yes, number of times:_____

Prior Knowledge and Experience

Rate your knowledge and experience with mechanical tasks and common hardware. Read each descriptor and circle the appropriate rating number on the scale at the bottom.

None or Little			**Moderate**			**Extensive**		
I have no training or practical experience in mechanical tasks or repairs. I can change a flat tire and/or perform minor home repair tasks involving common hand tools (screw driver, pliers, etc).			I have received classes or instruction from someone skilled in the use of common hardware and tools. I can perform minor automotive and/or in-home preventive maintenance and repairs. I have a complete tool set for routine home or roadside repairs.			I have received formal training as a mechanic or carpenter. I can perform engine or mechanical repairs on a lawn mower or automotive system. I am familiar with maintenance shop operations and logistics. I can perform aviation maintenance tasks.		
1	2	3	4	5	6	7	8	9

APPENDIX C

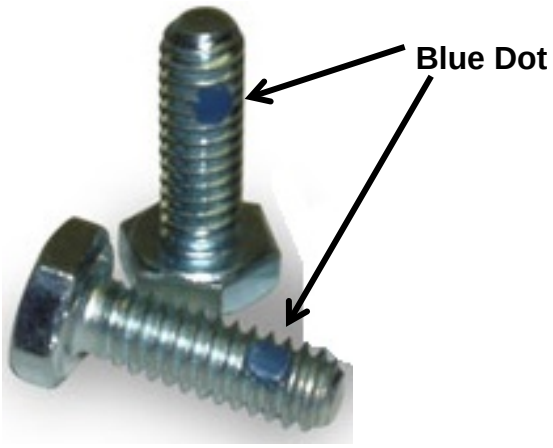
ALTERNATIVE TESTING FORMS EXAMPLE—VERSIONS A AND B

Version A

<u>Background and Instructions:</u> This assessment is for research purposes only. It will not be used for student evaluation, grade or score, class standing, or become a part of your military or academic record. Place an X in the space provided for your answer selection(s). Please refrain from guessing—if you don't know, pick that option.

Scenario: You are a member of a maintenance team that will be pre-flight inspecting a UAV for a first-light launch in the morning. This aircraft will support time-critical intelligence collection operations prior to an attack by a Heavy Brigade Combat Team (HBCT). A high operating tempo with multiple time-sensitive UAV launches is expected as the HBCT offensive operation commences. Several of your team mates are new and inexperienced. You are reviewing basics for tomorrow's early morning preflight operation and straightening up the shop and flightline area.

1. On the workbench, you find some bolts (pictured below) that were left out. From their appearance, what can you tell about them? (Note: One or more responses may be correct.)



_____ A. The blue dot identifies them as clevis bolts used in shearing stress applications.

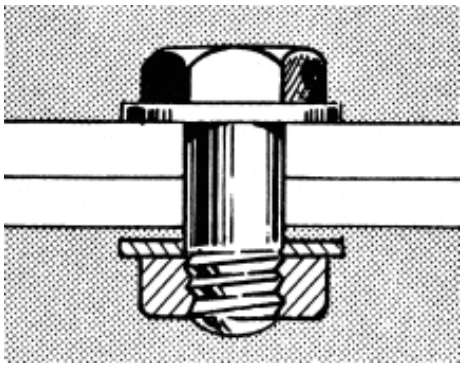
_____ B. They are self-locking bolts; the blue epoxy pellet ruptures when the bolt is tightened and the epoxy glue seals the bolt in the hole or to the nut for close tolerance applications.

_____ C. They are self-locking bolts; the nylon pellet inserted in the thread provides a tight assembly that resists vibration.

_____ D. The blue dot on the shaft identifies them as all-purpose structural bolts. The blue sealer material can be pressed out to use the hole drilled in the bolt shaft.

_____ E. I don't know.

2. For most aircraft applications, technical publications will provide the specifications for the bolts and fasteners to be used. However, when you have latitude, the right hardware should be selected. You examine some work (pictured below) done by a less experienced teammate. What conclusions can you draw? (Note: One or more responses may be correct.)



_____ A. The grip length on the bolt is too long; another bolt with a shorter grip length should be used.

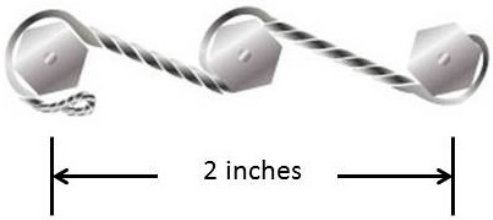
_____ B. The grip length on the bolt is too long; an additional washer could be added to cover the grip and provide a smooth bearing surface.

_____ C. The application is correct; bolt and grip length only matter for aircraft structural applications.

_____ D. The bolt is in upside down; bolts should be inserted from the bottom when possible and the nut tightened down for a more secure hold.

_____ E. I don't know.

3. The pressure plate cover bolts (pictured below) on the shop's air compressor have been secured with lock wire. What characteristic(s) of lock wire are used in or impact this application? (Note: One or more responses may be correct.)



_____ A. This application is okay since it can be inspected daily, but lock wire is the least preferred method of safetying fasteners and should only be used as a last resort in aircraft applications.

_____ B. Lock wire is very vulnerable to loosening due to vibration.

_____ C. Drilled head bolts are required for this type of lock wire application.

_____ D. When standard hexagonal head bolts are used, the wire under the bolt acts like a lock washer, providing friction between the fasteners and bearing surface to prevent loosening.

_____ E. I don't know.

4. What is the most common type of threaded fasteners used on aircraft? (Note: Only one response is correct.)

_____ A. Screws

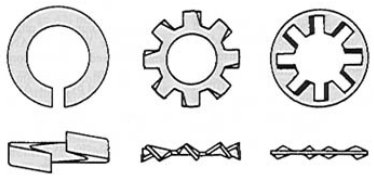
_____ B. Close tolerance bolts

_____ C. Self-locking bolts

_____ D. General purpose hexagonal bolts

_____ E. I don't know

5. Lock washers (pictured below) apply friction to prevent loosening of threaded fasteners. They are often used when self-locking bolts, castellated nuts, or drilled bolts are not appropriate for the application. What are some of the precautions that should be exercised when lock washers are used or being considered? (Note: One or more responses may be correct.)



_____ A. When used on soft metal surfaces, a plain washer should be used underneath to avoid damage and to provide a smooth bearing surface.

_____ B. Take extra care to prevent dissimilar metal corrosion (washer edges may scratch or score adjacent surfaces).

_____ C. Do not use them in places where washers and fasteners must be removed frequently.

_____ D. Do not use them on exposed surfaces that are subject to airflow.

_____ E. I don't know.

6. Many bolts are produced under design standards specified by Air Force and Navy Aeronautical Standards (AN). Military Standards (MS) are generally replacing AN standards. However, they are just different systems of specification. In some cases the MS spec is the same as the AN spec, but they use a different numbering system. For example an AN365-10 nut is the same as an MS20365-10 nut. Using Tables 2-2 through 2-5 of TM 1-1500-204-23-6, determine the AN number for a drilled shank, corrosion-resistant, steel bolt that has a 5/8 inch diameter and a two (2) inch length. (Note: Only one response is correct.)

_____ A. AN6C-14A

_____ B. AN9H13A

_____ C. AN10DD-21A

_____ D. AN10C-20

_____ E. I don't know.

7. Match the fastener type to the description for the images below. (Notes: Only one response is correct for each description. Match the best answers. Multiple pieces of hardware are shown for clarity. Not all hardware or item descriptions may have a match.)

_____ A. General purpose hexagonal head bolt

_____ B. Drilled head bolt

_____ C. Countersunk close tolerance bolt

_____ D. Internal wrenching bolt

_____ E. Worm screw hose clamp

_____ F. Clevis bolt

_____ G. Screw

_____ H. I don't know (Indicate letter(s)).

A.

B.

C.

D.

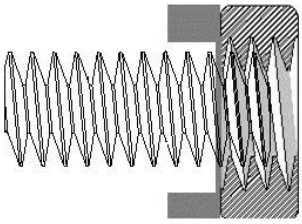
E.

F.

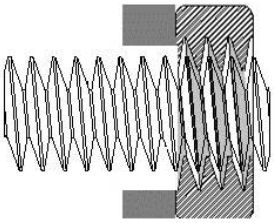
G.

H.

8. There are varied families of aircraft structural nuts. In most applications, the stresses of force press against the bolt or screw head, the shaft and grip, and the nut. All installation applications must minimize hardware failure and thread stripping. Which statement and image below best describes the minimum standard for the installation of a nut on a bolt or screw? (Note: Only one response is correct.)

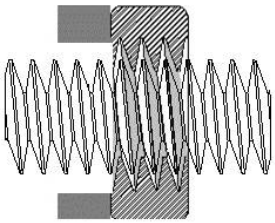


_____ A. Threads must penetrate at least one (1) full turn into the nut.

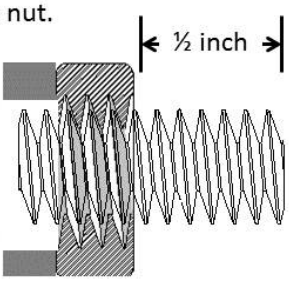


_____ B. Threads must penetrate through and be at least flush with the end of the nut.

.



_____ C. Threads must protrude through the nut at least two full sized threaded pitches



_____ D. Threads must protrude through the base of the nut at least ½ inch.

_____ E. I don't know.

9. Self-locking nuts (pictured below) are used to provide tight connections with or without the aid of additional locking devices. There are two types: 1) all metal and 2) non-metallic insert. Select the characteristics below which accurately describe the correct application of self-locking nuts. (Note: One or more responses may be correct.)

_____ A. Metal and non-metallic self-locking nuts are fully interchangeable in all applications except when the magnetic properties of metal self-locking nuts are required for improved safety.

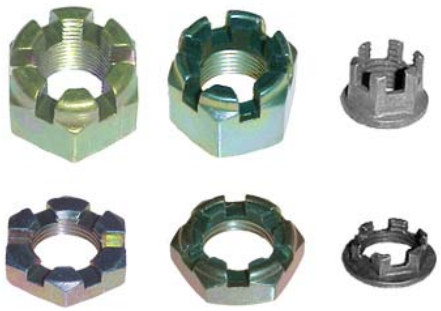
_____ B. Do not use a thread-cutting tap on either type; this will destroy the self-locking properties of the nut.

_____ C. Non-metallic self-locking nuts are filled with an epoxy or glue that ruptures during threading to seal the nut to the bolt or screw; the metal types contain lead or solder as the sealant.

_____ D. Drilled shaft bolts and screws (cotter pin holes, etc.) should never be used with self-locking nuts; the edges of the holes will distort the insert filler materials and bolt threads.

_____ E. I don't know.

10. Castellated nuts (pictured below) are designed for locking applications. Select the characteristics below which accurately describe the correct applications of castellated nuts. (Note: One or more responses may be correct.)



_____ A. Install these nuts with a drilled head bolt or screw.

_____ B. Apply the correct cotter pin, safety wire, or taper pin to secure the nut.

_____ C. Use plain washers to adjust the position of the nut with respect to the drilled shaft hole.

_____ D. When safety wire is used, bind only nuts to nuts or bolts to bolts (drilled head bolts and castellated nuts should never be secured together).

_____ E. I don’t know.

11. One of your maintenance teammates finished the repair pictured below late yesterday. Your Sergeant will not be pleased with the quality of this work. What steps or techniques listed below would make this a safer and more reliable locking application? (Note: One or more responses may be correct.)

_____ A. This cotter pin appears to have slack between the pin head and the bolt; tap or drive the pin into the bolt until the head is protected by the groves to prevent snagging and drift.

_____ B. This cotter pin appears to have slack between the pin head and the bolt; pull the cotter pin through the drilled hole in the bolt until the head is snug to the shank of the bolt.

_____ C. The preferred method of installation is with the pin head parallel to the slot in the nut, bend one prong over the end of the bolt and trim to ½ to ¾ of the bolt diameter. Bend the other prong down the castellation groove and trim at the base of the nut.

_____ D. The alternate method of installation to reduce snagging is to insert the pin head horizontal to the slot in the nut. Bend both prongs around the base of the nut in opposite directions and no trimming is required.

_____ E. I don't know.

12. Extensive wire runs are found throughout the UAV airframe. What types of **securing devices** are used to manage and secure electrical bundles and anchor wire bundles to fixed points inside the airframe? (Note: One or more responses may be correct.)

_____ A. Eye bolts with safety pins

_____ B. Dzus and camloc fasteners

_____ C. Worm screw-type clamps

_____ D. Lacing cord and cable or zip ties

_____ E. I don't know.

Version B

<u>Background and Instructions:</u> This assessment is for research purposes only. It will not be used for student evaluation, grade or score, class standing, or become a part of your military or academic record. Place an X in the space provided for your answer selection(s). Please refrain from guessing—if you don't know, pick that option.

Scenario: You are a member of a maintenance team that will be pre-flight inspecting a UAV for a first-light reconnaissance of Main Supply Route (MSR) Gold. This aircraft will support time-critical intelligence collection operations prior to route clearing operations by a Battalion Task Force of a Stryker Brigade Combat Team (SBCT). Should the Task Force encounter enemy contact, roadblocks, or improvised explosive devices (IEDs), a high operating tempo with multiple time-sensitive UAV launches is expected. Several of your team mates are new and inexperienced. You are reviewing basics for tomorrow's preflight operation and preparing the shop and flightline areas.

1. The cover plate bolts for the safety shroud (pictured below) on the shop's drill press have been secured with lock wire. What characteristic(s) of lock wire are used in, violate, or are impacted by this application? (Note: One or more responses may be correct.)

_____ A. Drilled head bolts are required for this type of lock wire application.

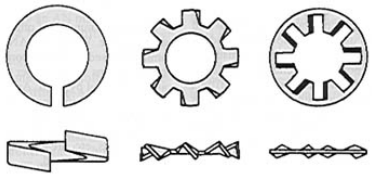
_____ B. The lock wire has been improperly installed and would release tension as vibration causes the bolts to loosen. This application should be corrected.

_____ C. Lock wire is the least preferred method of safetying fasteners and is used only as a last resort in aircraft.

_____ D. Even when correctly installed, lock wire is very vulnerable to loosening due to vibration.

_____ E. I don't know.

2. Lock washers (pictured below) apply friction to prevent loosening of threaded fasteners. They are often used when self-locking bolts, castellated nuts, or drilled bolts are not appropriate for the application. What are some of the precautions that should be exercised when lock washers are used or being considered? (Note: One or more responses may be correct.)



_____ A. Do not use them in places where washers and fasteners must be removed frequently.

_____ B. When used on soft metal surfaces, a plain washer should be used underneath to avoid damage and to provide a smooth bearing surface.

_____ C. Their low profile permits use on exposed surfaces that are subject to airflow.

_____ D. Take extra care to prevent dissimilar metal corrosion (washer edges may scratch or score adjacent surfaces).

_____ E. I don't know.

3. Many bolts are produced under design standards specified by Air Force and Navy Aeronautical Standards (AN). Military Standards (MS) are generally replacing AN standards. However, they are just different systems of specification. In some cases the MS spec is the same as the AN spec, but they use a different numbering system. For example an MS20365-10 nut is the same as an AN365-10 nut. Using Tables 2-2 through 2-5 of TM 1-1500-204-23-6, determine the AN number for an aluminum alloy bolt that has a 1¼ inch length, a 5/16 inch diameter, and a solid shank. (Note: Only one response is correct.)

_____ A. AN5DD-12A

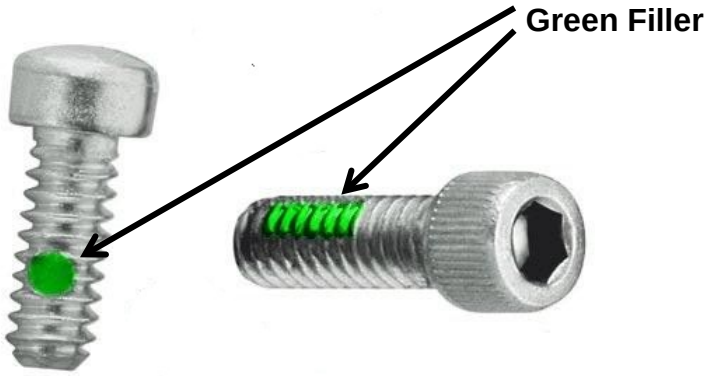
_____ B. AN6C-14

_____ C. AN10DD-21

_____ D. AN9H13A

_____ E. I don't know.

4. On the workbench, you find some bolts (pictured below) that were left out. From their appearance, what can you tell about them? (Note: One or more responses may be correct.)



_____ A. The marking on the shaft identifies them as all-purpose structural bolts. The green sealer material can be pressed out to use the hole or slot drilled in the bolt shaft.

_____ B. The green filler identifies them as clevis bolts used in shearing stress applications.

_____ C. They are self-locking bolts; the green epoxy pellet ruptures when the bolt is tightened and the epoxy glue seals the bolt in the hole or to the nut for close tolerance applications.

_____ D. They are self-locking bolts; the nylon pellet inserted in the thread provides a tight assembly that resists vibration.

_____ E. I don't know.

5. What is the most common type of threaded fasteners used on aircraft? (Note: Only one response is correct.)

_____ A. Screws

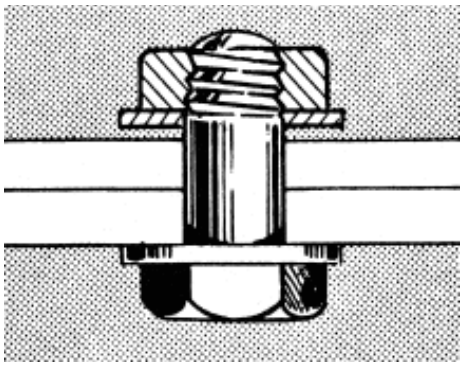
_____ B. Close tolerance bolts

_____ C. Self-locking bolts

_____ D. General purpose hexagonal bolts

_____ E. I don't know

6. For most aircraft applications, technical publications will provide the specifications for the bolts and fasteners to be used. However, when you have latitude, the right hardware should be selected. You examine some work (pictured below) done by a less experienced teammate. What conclusions can you draw? (Note: One or more responses may be correct.)



_____ A. The grip length on the bolt is too long; an additional washer could be added to cover the grip and provide a smooth bearing surface.

_____ B. The bolt is in upside down; bolts should be inserted from the top when possible and tightened down on the nut for a more secure hold.

_____ C. The grip length on the bolt is too long; another bolt with a shorter grip length should be used.

_____ D. The application is correct; bolt and grip length as well as position only matter for aircraft structural applications.

_____ E. I don't know.

7. Match the fastener type to the description for the images below. (Notes: Only one response is correct for each description. Match the best answers. Multiple pieces of hardware are shown for clarity. Not all hardware or item descriptions may have a match.)

_____ A. General purpose hexagonal head bolt

_____ B. Drilled head bolt

_____ C. Loop-type support clamp

_____ D. Internal wrenching bolt

_____ E. Clevis bolt

_____ F. Screw

_____ G. Countersunk close tolerance bolt

_____ H. I don't know (Indicate letter(s))

A. 

B. 

C. 

D. 

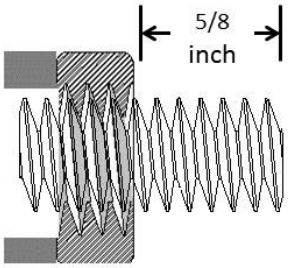
E. 

F. 

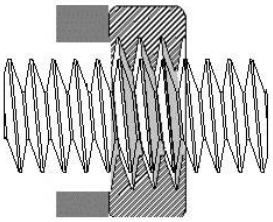
G. 

H. 

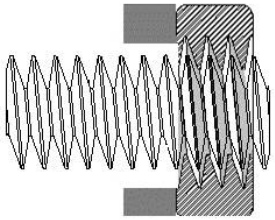
8. There are varied families of aircraft structural nuts. In most applications, the stresses of force press against the bolt or screw head, the shaft and grip, and the nut. Minimum standards of installation must be met to minimize hardware failure and thread stripping. Which statement and image below best describes the minimum standard for the installation of a nut on a bolt or screw? (Note: Only one response is correct.)



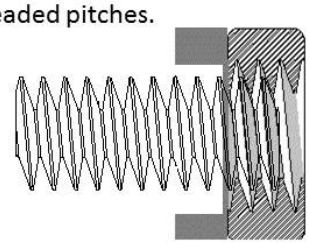
_____ A. Threads must protrude through the base of the nut at least 5/8 inch.



_____ B. Threads must protrude through the nut at least two full sized threaded pitches.



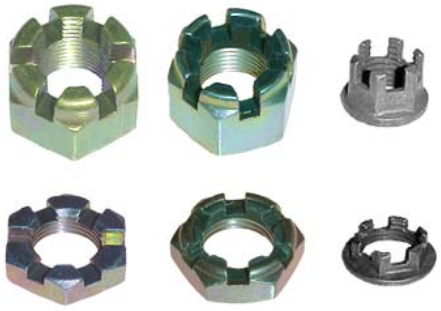
_____ C. Threads must penetrate through and be at least flush with the end of the nut.



_____ D. Threads must penetrate at least two (2) full turns into the nut.

_____ E. I don't know.

9. Castellated nuts (pictured below) are designed for locking applications. Select the characteristics below which accurately describe the correct applications of castellated nuts. (Note: One or more responses may be correct.)



_____ A. Use plain washers to adjust the position of the nut with respect to the drilled shaft hole.

_____ B. Install these nuts with a drilled head bolt or screw.

_____ C. Apply the correct cotter pin, safety wire, or taper pin to secure the nut.

_____ D. When safety wire is used, bind only nuts to nuts or bolts to bolts (drilled head bolts and castellated nuts should never be secured together).

_____ E. I don't know.

10. Extensive wire runs are found throughout the UAV airframe. What types of **securing devices** are used to manage and secure electrical bundles and anchor wire bundles to fixed points inside the airframe? (Note: One or more responses may be correct.)

_____ A. Eye bolts with safety pins

_____ B. Lacing cord and cable or zip ties

_____ C. Dzus and camloc fasteners

_____ D. Worm screw-type clamps

_____ E. I don't know.

11. One of your maintenance teammates finished the repair pictured below late yesterday. Your Sergeant will not be pleased with the quality of this work. What steps or techniques listed below would make this a safer and more reliable locking application? (Note: One or more responses may be correct.)

_____ A. This cotter pin appears to have slack between the pin head and the bolt; tap or drive the pin into the bolt until the head is protected by the groves to prevent snagging and drift.

_____ B. This cotter pin appears to have slack between the pin head and the bolt; pull the cotter pin through the drilled hole in the bolt until the head is snug to the shank of the bolt.

_____ C. The preferred method of installation is with the pin head parallel to the slot in the nut, bend one prong over the end of the bolt and trim to ½ to ¾ of the bolt diameter. Bend the other prong down the castellation groove and trim to the base of the nut.

_____ D. To reduce snagging, the alternate method of installation requires that the pin be inserted with the head horizontal to the slot in the nut. Bend both trimmed prongs in opposite directions around the bolt shoulders and into the honeycomb groves of the castellated nut.

_____ E. I don't know.

12. Self-locking nuts (pictured below) are used to provide tight connections with or without the aid of additional locking devices. There are two types: 1) all metal and 2) non-metallic insert. Select the characteristics below which accurately describe the correct application of self-locking nuts. (Note: One or more responses may be correct.)

_____ A. Metal and non-metallic self-locking nuts are fully interchangeable in all applications except when the magnetic properties of metal self-locking nuts have safety implications.

_____ B. Do not use a thread-cutting tap on either type; this will destroy the self-locking properties of the nut.

_____ C. Non-metallic self-locking nuts are filled with an epoxy or glue that ruptures during threading to seal the nut to the bolt or screw; the metal types contain lead or solder as the sealant.

_____ D. Drilled shaft bolts and screws (cotter pin holes, etc.) should never be used with self-locking nuts; the edges of the holes will distort the insert filler materials and bolt threads.

_____ E. I don't know.

APPENDIX D

INTERACTIVE MULTIMEDIA INSTRUCTION RATING QUESTIONNAIRE

Interactive Multimedia Instruction (IMI) Rating Questionnaire

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Complexity					
The IMI contained too much information.	○	○	○	○	○
The IMI contained too little information.	○	○	○	○	○
The amount of information in the IMI was just right.	○	○	○	○	○
Doctrinal Correctness					
The information presented seemed accurate and doctrinally correct.	○	○	○	○	○
The information presented seemed up-to-date.	○	○	○	○	○
Graphics					
The graphics supported the material being presented.	○	○	○	○	○
The displays on the screen were clear and legible.	○	○	○	○	○
Face Validity					
Based on my experience, the IMI presented the way the Army actually does things.	○	○	○	○	○
Uniforms, practices, and equipment were up-to-date.	○	○	○	○	○
Viable Examples					
Examples were presented in realistic mission context.	○	○	○	○	○
The examples made sense.	○	○	○	○	○
The examples contributed to my learning.	○	○	○	○	○
Repetition of examples was helpful.	○	○	○	○	○
Logical Flow					
The sequence of topics seemed to build on each other.	○	○	○	○	○
There was a good connection between the topics.	○	○	○	○	○
Focus of Presentation					
There was a clear focus of topics in the IMI.	○	○	○	○	○
The overall focus of the IMI was right on target.	○	○	○	○	○

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Grouping of Content					
I can recall how the IMI was structured.	○	○	○	○	○
I cannot recall how the IMI was structured.	○	○	○	○	○
Appropriate Testing					
Questions asked within the IMI were reasonable and helped me to understand the topic.	○	○	○	○	○
The questions asked within the IMI focused on what was being taught.	○	○	○	○	○
Interactivity and Navigation					
I felt like I was in control of my learning process.	○	○	○	○	○
Prompts and cues in the IMI assisted me in navigating through the material.	○	○	○	○	○
The IMI interactivity helped my learning process.	○	○	○	○	○
I could easily track where I was in the IMI.	○	○	○	○	○
Training Time					
I would be able to take breaks during the learning process and keep track of my progress.	○	○	○	○	○
Topics were the right length to allow me to complete without needing a break.	○	○	○	○	○
If I took a break during the learning process, I could easily resume learning when I returned.	○	○	○	○	○
Use of Prior Knowledge					
During the learning process, the IMI helped me remember things I already knew.	○	○	○	○	○
My prior knowledge and experience helped me understand what was being taught.	○	○	○	○	○
I did not need any prior knowledge or experience to learn from this IMI.	○	○	○	○	○
Optional Use					
I would use this IMI to refresh my skills at a later date.	○	○	○	○	○
I preferred this IMI to others I have used in the past.	○	○	○	○	○
I would recommend that this IMI be made available to all UAV Repair personnel.	○	○	○	○	○
Outcome Meets Goal					
I feel I have a better understanding of the subject after completing the IMI.	○	○	○	○	○
I learned a lot about the subject.	○	○	○	○	○

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I feel I could have a conversation and/or seek more information about the subject.	○	○	○	○	○
On the basis of this IMI, I could use this information to help me repair a UAV and related systems.	○	○	○	○	○
I feel this IMI was able to meet my individual learning needs.	○	○	○	○	○

Thank you for your participation.
This concludes our data collection.

APPENDIX E

INTERACTIVE MULTIMEDIA INSTRUCTION RATINGS SUMMARIES

Summary of Hardware IMI Ratings (*n* = 11)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Complexity					
The IMI contained too much information.	**0**	**2**	**3**	**5**	**1**
The IMI contained too little information.	**0**	**0**	**2**	**9**	**0**
The amount of information in the IMI was just right.	**1**	**5**	**3**	**2**	**0**
Doctrinal Correctness					
The information presented seemed accurate and doctrinally correct.	**2**	**8**	**0**	**1**	**0**
The information presented seemed up-to-date.	**3**	**7**	**1**	**0**	**0**
Graphics					
The graphics supported the material being presented.	**1**	**10**	**0**	**0**	**0**
The displays on the screen were clear and legible.	**1**	**10**	**0**	**0**	**0**
Face Validity					
Based on my experience, the IMI presented the way the Army actually does things.	**2**	**6**	**3**	**0**	**0**
Uniforms, practices, and equipment were up-to-date.	**3**	**7**	**1**	**0**	**0**
Viable Examples					
Examples were presented in realistic mission context.	**2**	**7**	**1**	**0**	**1**
The examples made sense.	**3**	**7**	**0**	**1**	**0**
The examples contributed to my learning.	**3**	**5**	**2**	**1**	**0**
Repetition of examples was helpful.	**2**	**7**	**0**	**2**	**0**
Logical Flow					
The sequence of topics seemed to build on each other.	**0**	**7**	**3**	**1**	**0**
There was a good connection between the topics.	**0**	**9**	**2**	**0**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Focus of Presentation					
There was a clear focus of topics in the IMI.	**3**	**8**	**0**	**0**	**0**
The overall focus of the IMI was right on target.	**2**	**8**	**1**	**0**	**0**
Grouping of Content					
I can recall how the IMI was structured.	**0**	**9**	**1**	**1**	**0**
I cannot recall how the IMI was structured.	**0**	**1**	**1**	**8**	**1**
Appropriate Testing					
Questions asked within the IMI were reasonable and helped me to understand the topic.	**2**	**8**	**0**	**1**	**0**
The questions asked within the IMI focused on what was being taught.	**3**	**7**	**1**	**0**	**0**
Interactivity and Navigation					
I felt like I was in control of my learning process.	**4**	**4**	**2**	**1**	**0**
Prompts and cues in the IMI assisted me in navigating through the material.	**1**	**8**	**1**	**1**	**0**
The IMI interactivity helped my learning process.	**3**	**5**	**3**	**0**	**0**
I could easily track where I was in the IMI.	**2**	**4**	**3**	**2**	**0**
Length of Training					
I would be able to take breaks during the learning process and keep track of my progress.	**3**	**4**	**4**	**0**	**0**
Topics were the right length to allow me to complete without needing a break.	**2**	**5**	**1**	**2**	**1**
If I took a break during the learning process, I could easily resume learning when I returned.	**3**	**6**	**2**	**0**	**0**
Use of Prior Knowledge					
During the learning process, the IMI helped me remember things I already knew.	**2**	**5**	**3**	**1**	**0**
My prior knowledge and experience helped me understand what was being taught.	**3**	**5**	**1**	**2**	**0**
I did not need any prior knowledge or experience to learn from this IMI.	**1**	**5**	**3**	**2**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Optional Use					
I would use this IMI to refresh my skills at a later date.	**4**	**3**	**3**	**1**	**0**
I preferred this IMI to others I have used in the past.	**0**	**2**	**7**	**1**	**1**
I would recommend that this IMI be made available to all UAV Repair personnel.	**2**	**6**	**1**	**0**	**2**
Outcome Meets Goal					
I feel I have a better understanding of the subject after completing the IMI.	**2**	**8**	**1**	**0**	**0**
I learned a lot about the subject.	**2**	**5**	**4**	**0**	**0**
I feel I could have a conversation and/or seek more information about the subject.	**3**	**6**	**2**	**0**	**0**
On the basis of this IMI, I could use this information to help me repair a UAV and related systems.	**1**	**5**	**5**	**0**	**0**
I feel this IMI was able to meet my individual learning needs.	**1**	**7**	**2**	**1**	**0**

Thank you for your participation.
This concludes our data collection.

Summary of Precision Tools IMI Ratings (*n* = 9)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Complexity					
The IMI contained too much information.	**0**	**0**	**2**	**5**	**2**
The IMI contained too little information.	**3**	**2**	**2**	**2**	**0**
The amount of information in the IMI was just right.	**0**	**2**	**4**	**3**	**0**
Doctrinal Correctness					
The information presented seemed accurate and doctrinally correct.	**2**	**4**	**2**	**1**	**0**
The information presented seemed up-to-date.	**3**	**5**	**0**	**1**	**0**
Graphics					
The graphics supported the material being presented.	**1**	**8**	**0**	**0**	**0**
The displays on the screen were clear and legible.	**0**	**7**	**0**	**1**	**1**
Face Validity					
Based on my experience, the IMI presented the way the Army actually does things.	**0**	**7**	**2**	**0**	**0**
Uniforms, practices, and equipment were up-to-date.	**3**	**4**	**2**	**0**	**0**
Viable Examples					
Examples were presented in realistic mission context.	**0**	**4**	**3**	**2**	**0**
The examples made sense.	**0**	**7**	**1**	**0**	**1**
The examples contributed to my learning.	**0**	**7**	**1**	**1**	**0**
Repetition of examples was helpful.	**0**	**7**	**2**	**0**	**0**
Logical Flow					
The sequence of topics seemed to build on each other.	**0**	**2**	**5**	**2**	**0**
There was a good connection between the topics.	**2**	**3**	**4**	**0**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Focus of Presentation					
There was a clear focus of topics in the IMI.	**2**	**5**	**1**	**1**	**0**
The overall focus of the IMI was right on target.	**2**	**5**	**1**	**1**	**0**
Grouping of Content					
I can recall how the IMI was structured.	**1**	**5**	**1**	**1**	**1**
I cannot recall how the IMI was structured.	**1**	**2**	**0**	**4**	**2**
Appropriate Testing					
Questions asked within the IMI were reasonable and helped me to understand the topic.	**1**	**5**	**3**	**0**	**0**
The questions asked within the IMI focused on what was being taught.	**1**	**5**	**3**	**0**	**0**
Interactivity and Navigation					
I felt like I was in control of my learning process.	**1**	**4**	**3**	**0**	**1**
Prompts and cues in the IMI assisted me in navigating through the material.	**1**	**3**	**2**	**3**	**0**
The IMI interactivity helped my learning process.	**1**	**5**	**3**	**0**	**0**
I could easily track where I was in the IMI.	**3**	**5**	**0**	**1**	**0**
Length of Training					
I would be able to take breaks during the learning process and keep track of my progress.	**1**	**5**	**3**	**0**	**0**
Topics were the right length to allow me to complete without needing a break.	**2**	**5**	**2**	**0**	**0**
If I took a break during the learning process, I could easily resume learning when I returned.	**1**	**6**	**1**	**0**	**1**
Use of Prior Knowledge					
During the learning process, the IMI helped me remember things I already knew.	**2**	**6**	**0**	**0**	**1**
My prior knowledge and experience helped me understand what was being taught.	**3**	**5**	**0**	**1**	**0**
I did not need any prior knowledge or experience to learn from this IMI.	**1**	**5**	**1**	**1**	**1**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Optional Use					
I would use this IMI to refresh my skills at a later date.	**2**	**5**	**1**	**0**	**1**
I preferred this IMI to others I have used in the past.	**1**	**3**	**4**	**1**	**0**
I would recommend that this IMI be made available to all UAV Repair personnel.	**2**	**4**	**2**	**0**	**1**
Outcome Meets Goal					
I feel I have a better understanding of the subject after completing the IMI.	**1**	**6**	**1**	**1**	**0**
I learned a lot about the subject.	**1**	**4**	**2**	**1**	**1**
I feel I could have a conversation and/or seek more information about the subject.	**1**	**6**	**2**	**0**	**0**
On the basis of this IMI, I could use this information to help me repair a UAV and related systems.	**1**	**6**	**0**	**1**	**1**
I feel this IMI was able to meet my individual learning needs.	**0**	**5**	**3**	**1**	**0**

Thank you for your participation.
This concludes our data collection.

Summary of Hydraulic Designer Controlled IMI Ratings (*n* = 6)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Complexity					
The IMI contained too much information.	**0**	**1**	**3**	**2**	**0**
The IMI contained too little information.	**0**	**0**	**2**	**2**	**2**
The amount of information in the IMI was just right.	**0**	**4**	**1**	**1**	**0**
Doctrinal Correctness					
The information presented seemed accurate and doctrinally correct.	**5**	**1**	**0**	**0**	**0**
The information presented seemed up-to-date.	**5**	**1**	**0**	**0**	**0**
Graphics					
The graphics supported the material being presented.	**6**	**0**	**0**	**0**	**0**
The displays on the screen were clear and legible.	**6**	**0**	**0**	**0**	**0**
Face Validity					
Based on my experience, the IMI presented the way the Army actually does things.	**1**	**2**	**3**	**0**	**0**
Uniforms, practices, and equipment were up-to-date.	**3**	**2**	**1**	**0**	**0**
Viable Examples					
Examples were presented in realistic mission context.	**2**	**3**	**1**	**0**	**0**
The examples made sense.	**1**	**4**	**0**	**1**	**0**
The examples contributed to my learning.	**3**	**2**	**1**	**0**	**0**
Repetition of examples was helpful.	**2**	**3**	**1**	**0**	**0**
Logical Flow					
The sequence of topics seemed to build on each other.	**3**	**3**	**0**	**0**	**0**
There was a good connection between the topics.	**4**	**2**	**0**	**0**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Focus of Presentation					
There was a clear focus of topics in the IMI.	**3**	**3**	**0**	**0**	**0**
The overall focus of the IMI was right on target.	**3**	**3**	**0**	**0**	**0**
Grouping of Content					
I can recall how the IMI was structured.	**1**	**2**	**2**	**1**	**0**
I cannot recall how the IMI was structured.	**0**	**1**	**2**	**3**	**0**
Appropriate Testing					
Questions asked within the IMI were reasonable and helped me to understand the topic.	**2**	**3**	**1**	**0**	**0**
The questions asked within the IMI focused on what was being taught.	**4**	**1**	**1**	**0**	**0**
Interactivity and Navigation					
I felt like I was in control of my learning process.	**0**	**2**	**1**	**3**	**0**
Prompts and cues in the IMI assisted me in navigating through the material.	**0**	**3**	**2**	**0**	**1**
The IMI interactivity helped my learning process.	**0**	**3**	**1**	**1**	**1**
I could easily track where I was in the IMI.	**0**	**4**	**1**	**0**	**1**
Length of Training					
I would be able to take breaks during the learning process and keep track of my progress.	**0**	**3**	**2**	**1**	**0**
Topics were the right length to allow me to complete without needing a break.	**1**	**3**	**1**	**1**	**0**
If I took a break during the learning process, I could easily resume learning when I returned.	**1**	**3**	**2**	**0**	**0**
Use of Prior Knowledge					
During the learning process, the IMI helped me remember things I already knew.	**1**	**1**	**3**	**1**	**0**
My prior knowledge and experience helped me understand what was being taught.	**1**	**2**	**1**	**2**	**0**
I did not need any prior knowledge or experience to learn from this IMI.	**2**	**3**	**0**	**1**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Optional Use					
I would use this IMI to refresh my skills at a later date.	**3**	**2**	**0**	**1**	**0**
I preferred this IMI to others I have used in the past.	**0**	**2**	**4**	**0**	**0**
I would recommend that this IMI be made available to all UAV Repair personnel.	**1**	**2**	**2**	**1**	**0**
Outcome Meets Goal					
I feel I have a better understanding of the subject after completing the IMI.	**2**	**3**	**1**	**0**	**0**
I learned a lot about the subject.	**2**	**3**	**1**	**0**	**0**
I feel I could have a conversation and/or seek more information about the subject.	**1**	**3**	**1**	**1**	**0**
On the basis of this IMI, I could use this information to help me repair a UAV and related systems.	**1**	**3**	**1**	**1**	**0**
I feel this IMI was able to meet my individual learning needs.	**0**	**4**	**1**	**1**	**0**

Thank you for your participation.
This concludes our data collection.

Summary of Hydraulic Learner Controlled IMI Ratings (*n* = 16)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Complexity					
The IMI contained too much information.	**0**	**2**	**9**	**4**	**1**
The IMI contained too little information.	**0**	**1**	**7**	**6**	**2**
The amount of information in the IMI was just right.	**2**	**6**	**6**	**1**	**1**
Doctrinal Correctness					
The information presented seemed accurate and doctrinally correct.	**5**	**10**	**1**	**0**	**0**
The information presented seemed up-to-date.	**5**	**8**	**3**	**0**	**0**
Graphics					
The graphics supported the material being presented.	**4**	**11**	**1**	**0**	**0**
The displays on the screen were clear and legible.	**8**	**6**	**1**	**1**	**0**
Face Validity					
Based on my experience, the IMI presented the way the Army actually does things.	**1**	**5**	**9**	**1**	**0**
Uniforms, practices, and equipment were up-to-date.	**2**	**10**	**3**	**1**	**0**
Viable Examples					
Examples were presented in realistic mission context.	**3**	**7**	**5**	**1**	**0**
The examples made sense.	**3**	**11**	**2**	**0**	**0**
The examples contributed to my learning.	**5**	**9**	**2**	**0**	**0**
Repetition of examples was helpful.	**4**	**5**	**5**	**2**	**0**
Logical Flow					
The sequence of topics seemed to build on each other.	**3**	**5**	**5**	**3**	**0**
There was a good connection between the topics.	**2**	**7**	**4**	**3**	**0**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Focus of Presentation					
There was a clear focus of topics in the IMI.	**4**	**11**	**0**	**0**	**1**
The overall focus of the IMI was right on target.	**5**	**10**	**0**	**0**	**1**
Grouping of Content					
I can recall how the IMI was structured.	**3**	**5**	**3**	**4**	**1**
I cannot recall how the IMI was structured.	**1**	**3**	**3**	**8**	**1**
Appropriate Testing					
Questions asked within the IMI were reasonable and helped me to understand the topic.	**2**	**7**	**4**	**2**	**1**
The questions asked within the IMI focused on what was being taught.	**2**	**11**	**3**	**0**	**0**
Interactivity and Navigation					
I felt like I was in control of my learning process.	**4**	**5**	**4**	**2**	**1**
Prompts and cues in the IMI assisted me in navigating through the material.	**2**	**9**	**1**	**3**	**1**
The IMI interactivity helped my learning process.	**2**	**6**	**5**	**2**	**1**
I could easily track where I was in the IMI.	**1**	**7**	**4**	**4**	**0**
Length of Training					
I would be able to take breaks during the learning process and keep track of my progress.	**0**	**8**	**3**	**5**	**0**
Topics were the right length to allow me to complete without needing a break.	**1**	**8**	**6**	**1**	**0**
If I took a break during the learning process, I could easily resume learning when I returned.	**0**	**11**	**2**	**3**	**0**
Use of Prior Knowledge					
During the learning process, the IMI helped me remember things I already knew.	**1**	**9**	**4**	**2**	**0**
My prior knowledge and experience helped me understand what was being taught.	**2**	**6**	**5**	**2**	**1**
I did not need any prior knowledge or experience to learn from this IMI.	**1**	**6**	**4**	**3**	**2**

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Optional Use					
I would use this IMI to refresh my skills at a later date.	**2**	**10**	**3**	**0**	**1**
I preferred this IMI to others I have used in the past.	**0**	**1**	**13**	**1**	**1**
I would recommend that this IMI be made available to all UAV Repair personnel.	**2**	**8**	**5**	**0**	**1**
Outcome Meets Goal					
I feel I have a better understanding of the subject after completing the IMI.	**3**	**9**	**3**	**0**	**1**
I learned a lot about the subject.	**2**	**8**	**5**	**0**	**1**
I feel I could have a conversation and/or seek more information about the subject.	**2**	**11**	**2**	**0**	**1**
On the basis of this IMI, I could use this information to help me repair a UAV and related systems.	**1**	**7**	**5**	**2**	**1**
I feel this IMI was able to meet my individual learning needs.	**2**	**6**	**6**	**1**	**1**

Thank you for your participation.
This concludes our data collection.